The Composition and Performance of Spatial Music

Enda Bates

Doctoral Thesis - Abstract

This thesis will examine the perceptual effectiveness of various works of spatial music in terms of the technical means of spatialization, and also the compositional approach to the use of space as a musical parameter. Particular attention will be paid to the effectiveness of different spatialization techniques in a performance context, and what this implies for compositional strategies which use space as a musical parameter.

The results of a large number of listening tests and simulations were analysed to determine the fundamental capabilities of different spatialization techniques under the less than ideal conditions typically encountered during a performance. It was found that stereophonic techniques based on amplitude panning provided the most accurate localization but suffered from a lack of spaciousness and envelopment. Ambisonics provides an improved sense of envelopment but poor localization accuracy, particularly with first order Ambisonics systems. Ambisonics was consistently preferred for dynamically moving sources as this technique eliminated the panning artefacts exhibited by amplitude panning as the source moved from a position at a loudspeaker, to one inbetween a pair of loudspeakers. A single-band, max-r_E decoding scheme was found to be the most suitable Ambisonics scheme for a distributed audience, and increasing the order of the system was shown to improve the performance at all listener positions. It is recommended that an octagonal array be adopted as a minimum standard for performances of multichannel spatial music, as this arrangement can be utilized for third order Ambisonics and can also be readily implemented with digital audio hardware.

Wavefield synthesis (WFS) was found to be quite distinct from multichannel techniques such as stereophony or Ambisonics. It was found that as the distance between loudspeakers in the array is increased, spatial aliasing results in significant soundfield reconstruction errors. The ability of WFS systems to position virtual sources both behind and in front of the loudspeaker array was found, in practice, to be extremely difficult to achieve.

In the latter half of this thesis, a number of landmark works of spatial music were presented and analysed in terms of the perceptual validity of their approach to spatialization. It was shown that many composers have used spatial distribution to improve the intelligibility of different layers of material, and this approach was found to agree with the findings of scientific research in the area of auditory cognition. The use of recognizable spatial motifs was shown to be highly difficult to achieve, and complex, abstract spatial designs were found to only be indirectly related to what is eventually perceived by the audience. A gestural approach to spatial music, and augmented instruments which map the actions of the performer to a spatialization algorithm, would both seem to be highly suitable for performances of mixed-media spatial music. The use of flocking algorithms to control spatialization and sound synthesis also appears to be a novel and effective approach to the creation of spatially dynamic, electronic sounds. Finally, a number of original compositions by the author are presented and analyzed in terms of the perceptual results discussed earlier in the thesis.